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THE RED SPIDER[1] ON COTTON AND HOW TO CONTROL IT.

By E. A. McGREGOR,
Entomological Assistant, Southern Field Crop Insect Investigations.

INTRODUCTION.

By the adoption of the preventive measures described in this bulletin it is possible to avoid the losses caused by the so-called red spider (fig. 1), a minute creature which seriously injured 20,000 acres of cotton in South Carolina in 1912, and is similarly destructive in other Southern States. Injury by the red spider in cotton fields may occur from the middle of June until the middle of September. It consists in a rusting and dropping of the leaves and sometimes in the death of the affected plants over considerable portions of the fields. For many years this trouble has been called "rust" by cotton planters, who concluded from the reddening of the leaves that it was a disease. The injury, however, is caused by the presence on the cotton leaves of multitudes of small mites called "red spiders."

GENERAL APPEARANCE AND NATURE OF DAMAGE.

The presence of the pest is first revealed by the appearance on the upper surface of the leaf of a blood-red spot. As leaves become more infested they redden or turn rusty yellow over the entire surface, become folded, then turn brown and dry, and finally drop. The lower leaves usually are first attacked, but infestation spreads upward until often only the bare stalk and one or two terminal leaves remain. (See figs. 2, 3, and 4.) Such plants almost always die.

[1] *Tetranychus telarius* L., generally known as *T. bimaculatus* Harvey, and in some publications as *T. gloveri* Bks.; order Acarina, family Tetranychidae.

In severe cases the dropping of the leaves is sufficient to prevent the development of lint. The loss of foliage, however, is always accompanied by the shedding of bolls, which may amount to the total loss of fruit or merely of the younger bolls. On the plants other than cotton, which the red spider often attacks, the appearance of the injury is similar to that on cotton, although it is unusual for most plants to show the red blotching. The feeding is done by means of sharp, slender, lance-like mouth parts which are thrust well into the leaf, usually on the under surface.

Injury results from the extraction by the red spiders of the juices of the plant leaves. It is plain, therefore, that the mites can not be killed by poisons sprayed onto the leaves, which may be devoured in feeding, but must be attacked by sprays which kill by contact.

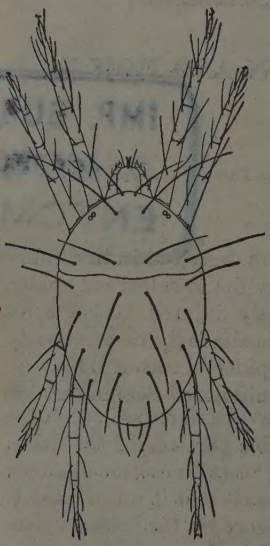

FIG. 1.—The red spider, *Tetranychus telarius:* Adult female. Greatly enlarged. (From Banks.)

EXTENT OF INJURY.

Unlike many pests the red spider does not occur continuously over large areas. Certain fields are infested while many others are free. Large fields are probably never damaged throughout, but smaller fields frequently become wholly affected. A thorough examination of all fields within 1 mile of the center of Leesville, S. C., was made during the height of the season with a view to determining the exact state of red-spider infestation in one locality. In all, 99 fields were examined as carefully as possible and about three-fourths of them were found to be infested. This occurrence was one of the severest and most general that has at any time come to the writer's attention. The worst infestation in the above-mentioned locality was one which spread from its point of origin until it extended in one direction 600 feet from the original source. (See fig. 5.) The area finally affected, semicircular in shape, comprised 13 acres, and within its boundaries the occurrence was general. While such a case as this is unusual, 4-acre or 5-acre spots with 25 to 100 per cent damage are frequently seen.

During 1912 about 20,000 acres of cotton in South Carolina were seriously infested by the red spider. Since the yield thus lost is about two-fifths of a normal crop on this area, or 2,716,000 pounds, it will be seen that at 12 cents per pound this lost lint represented a

tax of $325,920. The cotton seed lost, at ordinary prices amounting to $67,900, brought the total levy on the South Carolina planters to about $393,820. In view of the fact that North Carolina, Georgia, Alabama, and Mississippi suffer similarly and are each considerably larger than South Carolina, it is estimated that during a severe red-spider year the southeast may suffer a loss of $2,000,000 from the ravages of this pest.

FIG. 2.—An uninfested cotton plant, growing in same field shown in figure 5, but just beyond the boundary of infestation by the red spider. (Author's illustration.)

DESCRIPTION OF THE RED SPIDER.

Both male and female red spiders are present on the plants. The color of the females is subject to considerable variation. At times it is rusty green, sometimes greenish amber, occasionally yellowish, at times almost black, but most often brick red, and a large spot of much darker color is usually seen along the back half of each side of the body. The males are considerably smaller than the females, more pointed behind, of a rusty salmon color, and the spots at the sides are not conspicuous. The red spider is in reality not a spider but a mite, and is more nearly related to the ticks than to the true spiders. As is usnal with mites, both the male and the female have eight legs, but no wings. The females are less than one-fiftieth of an inch in length.

LIFE HISTORY AND HABITS.

The red spiders which pass through the winter are chiefly the mature females. Males, however, may also be seen at times during this season, and, indeed, during periods of mild weather eggs are laid and considerable development may take place. Upon several

occasions at Batesburg, S. C., all stages of the red spider have been seen in winter on plants in outdoor locations. Feeding continues more or less, depending on the temperature, on several species of plants which bear leaves throughout the winter.

FIG. 3.—Cotton plant in an early stage of infestation by the red spider. Many leaves are discolored and some of the lower ones have dropped. (Author's illustration.)

The great mass of red spiders pass the winter on wild plants, and since these support the mite during the time of year when it is most difficult for the pest to survive it is clear that the wild plants are of great importance. Among the more common of these winter plants are hedge nettle, evening primrose, Jerusalem oak, wild blackberry, sow thistle, wild geranium, and wild vetch.

With the recurrence of warm spring days, the red spiders multiply much faster until their winter food plants become too crowded to support them properly. New feeding grounds then become necessary, and migrations take place which carry them to numerous species of spring plants and weeds.

The first spring generation of females usually develops about March 31. From this date until about May 31, when cotton becomes attractive to the pest, the red spider advances from the winter plants in several successive migrations. During this interval five broods of red spiders usually develop, so that each wintering female by the first of June has produced, theoretically, over 300,000,000 offsprings. In the meantime most weeds and garden plants that stand in the path of the red spider's advance become infested.

FIG. 4.—Cotton plant in well advanced stage of infestation by the red spider. Nearly all leaves, squares, and bolls have been shed. (Author's illustration.)

During the spring and summer months the red spider, in the latitude of South Carolina, requires on an average a little less than

11 days for the completion of a generation. In an average season at Batesburg, S. C., there are 17 generations of red spiders.

In developing from the egg to the adult stage the red spider follows one or the other of two distinct courses, depending on the sex. With the female, the egg hatches in about four days to a tiny, colorless, 6-legged form known as a larva, which feeds eagerly, and in about two days in summer time sheds its skin and becomes an 8-legged form called the primary nymph. The latter feeds in a manner very similar to that of the larva, and becomes greenish or yellowish in color with conspicuous blotches at the sides. At Batesburg this stage requires a trifle over two days for completion, when the skin is again shed and the secondary nymph appears. The

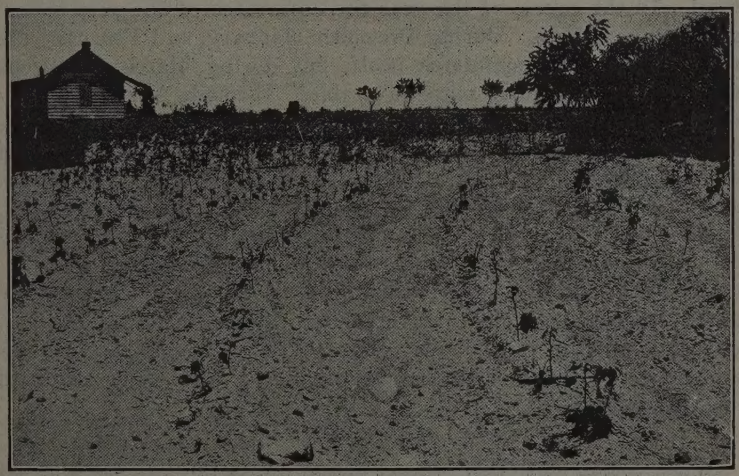

FIG. 5.—A severe example of red-spider work in a cotton field. Nearly all plants in the foreground are in the condition shown in figure 4. The source in this case was certain pokeweed stalks growing in the weed border seen in the upper right-hand corner of the figure. (Author's illustration.)

latter lives about as the preceding stages do and becomes more nearly the size and color of the adult. After about one and nine-tenths days another molt or skin shedding occurs which gives origin to the adult female. Thus, for the most favorable season, the females require about nine days to mature.

The development of the male is very similar to that of the female with the difference that the second nymphal stage is lacking. The other stages, however, are slightly lengthened, so that the male red spiders usually complete their development only one day sooner than do the females.

In establishing herself upon cotton the female selects a concave area between the under veins of the leaf and, after a brief feeding

period of about 18 hours, begins to deposit her eggs. They are usually clustered rather closely, rarely occupying an area greater in size than that of a dime.

For about 8 to 10 days the female lays usually about six eggs per day, thus making a total of about 50 to 60 eggs. Feeding continues from time to time throughout the egg-laying period. The average duration of adult life in summer, in South Carolina, is about 12 days. This period increases as the weather becomes cooler, and in winter the adults often live for 150 days.

RELATION OF WEATHER TO BREEDING.

Climatic conditions influence the development of the red spider to a marked extent. The influence may be either harmful or beneficial. In the course of the year the occurrence of the pest undergoes many changes. During December, January, and February the red spider merely maintains itself, but during March conditions usually become a little more favorable. Through April and May development progresses most rapidly, and infestation reaches its height on miscellaneous plants by June 1. Beginning about the end of September, a reduction begins in the numbers of the red spider, and this reduction continues as the weather becomes colder, until, by the end of November, the low point is again reached. Hot, dry conditions, such as occur during times of drought, hasten development, while cool, wet weather retards it. A female laying normally about six eggs per day will, upon the occurrence of a hot day, suddenly increase the number, often to 15 or 20 eggs per day, or upon a chilly day the number deposited may drop as suddenly to one egg or none.

DISPERSION.

When cotton and other annual plants die in the late fall the red spiders are forced to seek green food. Many of them manage to locate upon the several kinds of weeds (mentioned on page 4) which remain green throughout the winter. Since these wild plants occur abundantly in the borders of fields and on terraces and roadsides, the pest frequently is found on cotton the following spring, in the portions of fields where planters fail to clear these borders of weeds.

The cultivated violet occurs frequently throughout the South, and remains green through the winter. Infested violet beds have been found from Virginia to Texas, and in many cases they are the sources of infestation to near-by cotton fields. The infestation to cotton may arise directly from violets, if the beds are within a few hundred feet of cotton (fig. 6), or from a series of migrations covering considerable distances.

A peculiar sort of red-spider infestation arises from pokeweed, which occurs commonly on terraces and along field borders. Owing to its long growing period it rarely becomes heavily infested until

midsummer, so that infestation from this weed to cotton is usually noticed later than from violets or spring weeds.

It has been found that adult females are able to travel over smooth surfaces at the rate of about 5 inches per minute, or 600 feet in 24 hours. When forced to migrate through the scarcity of proper food, they commonly take to the ground and travel to other plants. During heavy rains many red spiders are dashed to the ground and carried considerable distances in the surface water, whereupon those not killed establish themselves on the plants that are near by. Heavy winds also at times blow them from place to place. When the injury becomes severe in a portion of a field it is common for the red spider to spread directly from plant to plant by means of the interweaving branches.

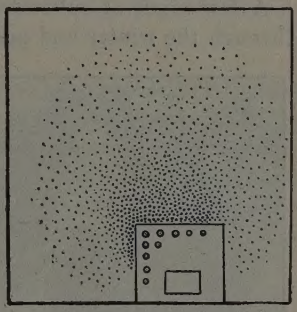

FIG. 6.—Diagram showing how violets growing in dooryard give rise to red-spider infestation in adjoining cotton field. The infestation is most severe near the yard. This diagram is typical of many cases found during 1911. (Author's illustration.)

PLANTS ATTACKED.

The red spider has been found breeding on nearly 200 species of plants, including weeds, ornamental plants, and garden and field crops. The following list of food plants, arranged in the order of their susceptibility to red-spider attack in the cotton belt, includes those most commonly infested: Cotton, cultivated violet, sow thistle, hollyhock, dahlia, garden beans, corn, tomato, onion, carnation, sweet pea, hedge nettle, nasturtium, morning-glory, clover, wild vetch, ironweed, Jerusalem oak, wild geranium, evening primrose, pokeweed, and strawberry.

NATURAL ENEMIES.

The red spider on cotton is attacked by over 30 predaceous enemies, which render valuable assistance in its control. Of these, 5 are mites, 3 are thrips, 4 are bugs, 4 are lacewing flies, 2 are midges, 4 are syrphid flies, 8 are lady beetles, and 1 is a caterpillar

REMEDIES FOR THE RED SPIDER.

PREVENTIVE MEASURES.

The solution of the red-spider problem must be accomplished through preventive efforts rather than curative, if it is to be done with economy. The location of the mites through the winter and spring, their rapid development on a few wild and cultivated plants,

and the manner of dispersion of the pest lead to the following cultural recommendations.

WEED DESTRUCTION.

Many weeds and plants serve as sources of dispersion. By destroying, during the winter and early spring, pokeweed, Jerusalem oak, jimson weed, wild blackberry, wild geranium, and other weeds in and around cotton fields, the greatest step toward red-spider control will have been taken. This plan has been tested in several instances and has given complete immunity the following season.

CONTROL ON DOORYARD PLANTS.

A few kinds of cultivated plants, especially violets, remain green through the winter and are well adapted to serve as winter hosts of

FIG. 7.—Portable barrel pump for application of herbicide to weed borders.

the red spider. Many cases of cotton infestation can be traced to near-by dooryards. The beds of violets and other plants should be thoroughly sprayed as soon as they show signs of infestation. The most satisfactory solution, where violets are concerned, consists in their removal or complete destruction.

HERBICIDES.

Certain chemical sprays can be applied to weed and plant borders, which kill them rather quickly. Of these, sodium arsenate, used at the rate of 1 pound to 20 gallons of water, is the most satisfactory. The ease and speed of destruction that accompany the use of such a remedy justify urging its use as a substitute for the old-fashioned

and tedious hoeing method. (See fig. 7.) It must be remembered, however, that sodium arsenate is a poison, and care should be taken to prevent horses and cattle from grazing on treated weeds.

SPACING.

Some have claimed that infestation spreads through a field only by means of the interlacing cotton branches, and that by increasing the spacing the spread of the red spider can be prevented. Since it is now known, however, that the mites commonly travel on the ground also, from plant to plant, it is easily seen that wide spacing of cotton plants will by no means entirely prevent the spread of the pest.

MAINTAINING MULCH.

By maintaining continually in fields a finely pulverized surface mulch the progress of migrating mites is somewhat retarded and the development of infestation correspondingly discouraged. The planting of cotton by the checking system permits the cultivation of each plant on four sides and is a good method from the viewpoint of the control of the red spider.

ROTATION.

Since the wild grasses and small grains appear to be about the only plants which are free from red-spider attack, there is little in the way of immune crops which can be used for the purpose of rotation. Furthermore, provided the sources of infestation were allowed to remain, the pest would surely reinvade fields, upon the return to cotton, even should the small grains or grasses be planted for a time.

FERTILIZERS.

Although the fertilizing of cotton land in no way discourages the development of red spiders, yet the judicious use of fertilizers invigorates the plants so that they are better fitted to overcome the injury.

REPRESSIVE MEASURES.

Under the heading "Repressive measures" may be discussed those measures which can be taken to combat the pest when it has gained entrance to cotton fields. It has been demonstrated that it is possible to eradicate the pest from infested fields.

By keeping a constant watch of cotton fields the earliest affected stalks may be detected and destroyed. In this method it is usually necessary to repeat the operation several times, since certain plants

are likely to be overlooked during the first inspection. Great care should be taken to locate every plant which shows infestation, and these must be taken from the field, without brushing against healthy plants, and burned immediately. If infestation has not advanced too far, the prompt application of this method is usually effective.

If infestation has spread until a considerable patch has become involved, more drastic steps are necessary than those just mentioned. Where a continuous area of infestation occurs in a large field, it is often advisable to plow up the worst affected portion and spray the rest of the infestation in order to save the balance of the field. The stalks should be quickly piled up and burned with the aid of straw or light trash. Such a severe measure should only

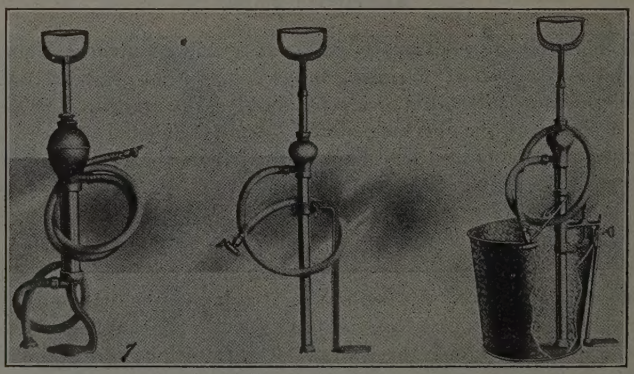

FIG. 8.—Bucket spray pump. (From Quaintance illustration.)

be resorted to in extreme cases, and the planter concerned must be the judge of its advisability.

INSECTICIDES.

Out of 75 different spray combinations tested against the red spider on cotton the following have been found to be thoroughly satisfactory: (1) Potassium sulphid (1 ounce to 2 gallons water); (2) lime-sulphur (homemade or commercial); (3) kerosene emulsion (prepared according to usual formula); (4) flour-paste solution (1 gallon stock paste to 12 gallons water). Spraying for the red spider is effective if it is done with extreme care. The foregoing sprays, when properly applied, kill all mites, but *a second spraying, one week later, is necessary to kill the individuals that were in the egg stage at the time of the first spraying.* Arsenical sprays are of no use against red spiders.

SPRAYING OUTFITS.

The sort of outfit to be used for spraying the red spider on cotton depends mainly on the extent of the occurrence. Many prefer to use a small tin atomizer when only a score or so of plants are to be treated. These instruments are very economical of liquid and throw a very fine, vapory spray which reaches all parts of the plants. The bucket pump (fig. 8) and knapsack pump (fig. 9) come into use in cases of considerable scattered infestation, or for treatment of a few plants in tall cotton where the platform pump would be undesirable. The most economic outfit for a severe case comprising several acres consists of a barrel pump carried through the field on a wagon or specially constructed vehicle of some sort. Figure 10 is from a photograph of a portable outfit used very successfully in demonstration work in North Carolina. It consists of a platform built upon the axle and shafts of a dismantled hayrake. The wheels are large, bringing the axle well above the ground, so that the vehicle does very little damage to the plants. Since the gauge of the outfit is 8 feet, it straddles two cotton rows, the single draft animal walking in the middle between these rows. A barrel pump with a capacity of 50 gallons is mounted on the platform. A boy drives, one man pumps, and two men handle the two sprayers. Thorough treatment of 4 acres per is readily obtainable with these devices.

FIG. 9.—Knapsack sprayer. (From Quaintance.)

NECESSITY FOR THOROUGH SPRAYING.

Some dissatisfaction has been experienced among certain planters who have undertaken to check the ravages of the red spider by spraying. With pests which devour the entire leaf, such as potato "bugs," cotton caterpillars, etc., even the careless application of Paris green to the top of the foliage often proves entirely satisfactory. This is explained by the fact that pests of that kind are constantly moving from leaf to leaf and are sure to get some of the poisoned foliage. Also, since these insects usually eat completely through the leaf, it matters little upon which side the poison falls. With the red spider, however, it is very different. A contact insecticide is absolutely necessary, and since the mite spends its life on the underside of

a single leaf it is most important in spraying to *hit the entire underside of every leaf of an infested plant.* Careless spraying is certain to yield unsatisfactory results.

SUMMARY OF REMEDIES.

To prevent injury to cotton by red spiders the following steps should be taken: (1) Destruction of all weeds around the farm dur-

FIG. 10.—Ideal spraying outfit for treatment of considerable red-spider infestation.

ing the winter and early spring; (2) spraying of cultivated plants around the dwellings; (3) maintaining a finely pulverized surface soil; (4) destruction of early infested plants or large areas of heavy infestation by plowing up and burning; and finally (5) spraying with potassium sulphid, lime-sulphur, kerosene emulsion, or a flour-paste solution if the infestation is more or less general.

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